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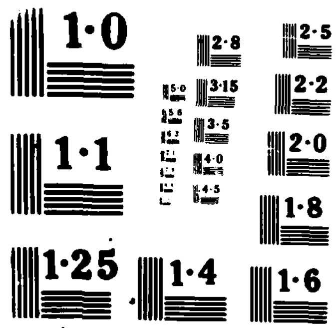
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# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

EFFECTS OF SIMULATED SHIP MOTION
ON THE PERFORMANCE OF
UNDERWAY OFFICER OF THE DECK

by

Lesa A. McComas

March 1986

Thesis Advisor: Judith H. Lind

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# Effects of Simulated Ship Motion on the Performance of Underway Officer of the Deck

by

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## ABSTRACT

The objectives of this study were twofold: to identify those cognitive skills required by the shipboard officer of the deck (OOD), and to determine if these skills are affected by simulated ship motion. The Position Analysis Questionnaire (PAQ) was used to analyze the duties of the OOD, and the important areas so identified were tested using the Automated Portable Test System (APTS) and a ship motion simulator. Analysis of the results revealed statistically significant effects on OOD performance due to motion in the areas of visual search and reasoning. In addition, there is some graphical indication that either higher or lower error rates are associated with motion, depending on the nature of the task.

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# I. INTRODUCTION

## A. BACKGROUND

The underway officer of the deck (OOD) onboard a naval vessel holds complete responsibility under the commanding officer for virtually everything happening both on and to the ship during his watch. This responsibility entails a large number of diverse tasks, calling on many different skill areas. These tasks must be performed concurrently, and often under less than ideal working conditions. Frequently, the OOD is subject to such potential causes of stress as extremes of temperature, ship motion due to inclement weather, and fatigue due to loss of sleep, overwork, or conflicts with his normal diurnal rhythm.

In a study of mishaps at sea in the Coast Guard (System Development Corporation, 1984a), it was determined that the greatest single primary cause of mishaps was human error. In another study (System Development Corporation, 1984b) the author investigated the causes of this phenomenon. Risk (hazardous working conditions), intensity of operational tempo, boredom and monotony, sleep disturbance, and rough seas all contributed to preventing the crew from performing at their peak. The author warns that human error is more commonly a factor in mishaps than accident reports indicate, as those involved often believe that admitting to fatigue or stress is a sign of weakness.

This study focuses on ship motion, one of the factors which can contribute to crew performance decrement. The purpose is not to investigate the long term effects of constant motion in a vigilance situation, but to determine if the presence of motion presents a short term hindrance to the cognitive abilities needed by an OOD.

## B. OBJECTIVES

This study has the following primary objectives:

(1) Ascertain what cognitive skills are needed by the underway officer of the deck.

(2) Test qualified OODs under conditions of non-motion and simulated ship motion to determine if these skills are affected by motion.

(3) If such an effect is found for any of the skills, investigate further to determine if the effect is positive or negative.

Additional secondary objectives for the study include:

(4) Explore the relationships between overall performance on the appropriate cognitive tests and certain items of background data, including level of experience and performance on one traditional intelligence test.

(5) Evaluate the computerized test system used for this study to determine how well it fulfills the requirements of testing for this purpose.

## II. STRESS AND MOTION

### A. STRESS

As yet, no precise scientific definition of stress has been fully agreed upon. In one good definition, Selye (1979) defines stress as "The non-specific response of the body to any demand." He divides this response into three phases:

(1) Alarm reaction, occurring at the onset of the stressful condition. This phase includes both the shock reaction, and the countershock reaction, in which the organism begins to muster its defensive capabilities to combat the stress.

(2) Resistance stage, which is characterized by full adaptation to the stressful condition, although the resistance to other stimuli is decreased.

(3) Exhaustion, which occurs when the individual's capacity to adapt is eventually surpassed.

The effects of stress on performance are not the same for all stressors. Hockey (1979, p. 142) defines a stressful condition as one which increases arousal. He notes that sleep loss does not fit this definition, as it has the tendency to decrease arousal, and indeed the effects of sleep deprivation are often quite different from those of other forms of stress. Broadbent (1971, p. 408) notes that the effects of noise and sleep loss are actually antagonistic to each other under some circumstances.

Mild stress, which increases arousal, may have the effect of improving performance. The Yerkes-Dodson law (Hockey, 1979, p. 143) states that for every task there exists a level of arousal such that performance is optimized at that level, and tends to decline with either more or less arousal. Additionally, the law states that the more

difficult the task, the lower the level of arousal optimal for that task.

As stress-induced arousal increases past the optimal level, the deterioration of performance that takes place is not general, but is more specific (Hockey, 1979, p. 163). The subject tends to increase the selectivity of both attention and response, focusing on those areas with the highest probability of containing useful information and ignoring all others.

Broadbent (1971, p. 402) discusses the effects of noise, high temperature, and sleep loss on tests of continuous serial reaction. These types of tests are time limited, presenting a new stimulus as soon as the current one has been correctly responded to. The effect normally noted is not slower reaction time, but is an increase in the error rate. However, the timing and degree of the effect differs for the different stressors, indicating the possibility of a different mechanism for each.

## B. MOTION

Motion is an ever-present shipboard form of environmental stress that could have a negative impact on the performance of the OOD. There are two distinct types of motion mentioned in the literature: vibration, and very low frequency (VLF) vibration, more commonly thought of as "motion". Although vibratory movement is not evaluated as a part of this study, a brief summary of its effects is provided, since the bulk of movement-related research has been related to vibration, and the many common factors between the two types of motion make the information worthwhile.

### 1. Vibration

Vibration is generally defined to be repeated movement at a frequency greater than 1 Hz, while motion (VLF vibration) is defined as movement at a rate slower than 1 Hz. (Human Factors Engineering Branch, 1977, p. 1)

Shoenberger (1974), and Lewis and Griffin (1976) found effects on cognitive performance in studies of vibration. The authors believe that most of the detrimental effect can be attributed to the mechanical aspects of motion. Shoenberger's task involved the use of vision in a memory-reaction time task. He found that visual blurring caused the subjects' performance to decline, but found no evidence of vibration interfering with the subjects' central processing capabilities. Lewis and Griffin studied a manual tracking exercise, and, similarly, found that the subjects' performance degradation was primarily due to the vibration interfering with the normal kinesthetic feedback mechanisms used to control arm motion.

Some types of vibrational movement are more performance degrading than are others. Sjoflot and Suggs (1973) found that vertical vibrations degrade performance far less than either transverse (side to side), or longitudinal (front to back) vibrations. Allen (1971) found that the interaction between the effects of different vibrational directions is considerable.

2. <u>VLF Vibration</u>

There has been less investigation into VLF vibration than there has been with higher frequency vibrations. Studies of the kind of motion associated with a ship have been especially limited in number and scope because of the difficulty involved in building a realistic simulator. The large (10-20-foot) rise and fall associated with a ship in heavy seas can only be adequately simulated by an apparatus with a similar range of motion (Yonekawa, 1972). The Aerospace Medical Research Laboratory Vertical Accelerator is such a simulator (Shoenberger, 1975), but its use has largely been limited to the study of motion sickness, and in producing scales of discomfort to be used in occupational safety and health guidelines.

From the limited studies done to date, the difference between effects due solely to the motion itself, and those due to motion sickness appears to be surprisingly clear cut. A Coast Guard study (U.S. Department of Transportation, 1980) found that performance appeared to decline at the advent of motion sickness, but not before. Similarly, the Human Factors Engineering Branch at Pt. Mugu Naval Missile Center (1975, p. 5) failed to find a gradual performance decrement associated with motion, but instead found an abrupt decline coinciding with the onset of physical symptoms (vomiting).

# III. POSITION ANALYSIS QUESTIONNAIRE

## A. BACKGROUND

In order to identify the skill areas of greatest importance to the OOD an analysis of the duties performed on the watch is necessary. Fortunately, a questionnaire designed for this task is already available.

The Position Analysis Questionnaire (PAQ) is a tool used by industry as well as the Navy to assess the types of skills required by a job. The test version used for this study is from Harris and McCormick (no date). Key questions are reproduced in Appendix A. The questionnaire consists of 186 job attributes. For each of these the respondent assesses the importance of that attribute to his job, or its frequency of use, or some other similar grading, on a scale of 1 (low) to 5 (high). The PAQ has been shown to be a good predictor of such things as job status and pay, and as a way of accurately comparing different positions for underlying similarities (CNO, no date).

McCormick and others (197[illegible], p. [illegible]) describe the major areas investigated by the PA[illegible]. These are:

(1) Information input
(2) Mediation processes [illegible]
(3) Work output [illegible]
(4) Interpersonal [illegible]
(5) Work situation [illegible]
(6) Miscellaneous [illegible]

For purposes [illegible] questions are [illegible] generally [illegible]

According [illegible] is intended [illegible] as a

screening tool. In other words, it is designed to match the strengths of an individual with the best possible job for him. An established data base for the candidate positions is considered a good predictor of job holder skills. The gravitational hypothesis of McCormick and others (1972, p. 52) postulates that individuals tend to be attracted to and to stay with jobs they are good at, and to leave those that they are not good at. This argues for minimizing attrition by matching the job to the person initially. Additionally, it is hypothesized that the PAQ is a good predictor because even basic skills thought to reflect innate ability may be honed with practice.

One study which confirmed the value of the PAQ in defining work attributes was conducted by Shannon (NBL, 1982). In this study, the PAQ was used to predict skills for Navy E-2 combat information control officers and operations specialists. The PAQ results were supplemented by interviews and observations of the work environment. The high correlation between the different respondents' answers indicated that the PAQ presents a good picture of the jobs.

Carter and Biersner (NBL, 1982) attempted to correlate PAQ scores with tests in the Armed Services Vocational Aptitude Battery (ASVAB). They succeeded in showing a correlation between skills required and skills posessed by the respondents. Overall, the PAQ appears to be ideally suited to assess OOD skill areas for this study.

## B. METHOD

The PAQ was administered to seven Naval surface warfare lieutenants. A PAQ question was considered relevant to this study if it fulfilled the following two criteria:

(1) It received a mean score greater than or equal to four (of five).

(2) It pertained to a mental skill, rather than a physical ability or an environmental factor.

## C. RESULTS

Table 1 summarizes the results of the survey, listing the PAQ question number, average score, and related skill areas for those questions meeting the above criteria. The complete PAQ questions listed in Table 1 are presented in Appendix A.

TABLE 1

PAQ RESULTS

| Question | Mn Score | Skill Areas |
|---|---|---|
| 5 | 4.71 | Use of visual displays |
| 11 | 4.14 | Observational ability (objects) |
| 13 | 4.86 | Observational ability (events) |
| 15 | 4.14 | Use of verbal information |
| 29 | 4.29 | Ability to estimate speed |
| 36 | 4.57 | Decision making skills |
| 37 | 4.14 | Reasoning ability |
| 39 | 4.43 | Integration of information |
| 40 | 4.29 | Analysis of information |
| 45 | 4.29 | Short term memory |
| 104 | 4.29 | Information exchange (routine) |
| 105 | 4.43 | Information exchange (non-routine) |
| 175 | 4.14 | Attention to detail |
| 176 | 4.14 | Recognition skills |
| 177 | 4.71 | Vigilance (infrequent events) |
| 178 | 4.71 | Vigilance (changing environment) |
| 180 | 4.43 | Ability to update memory |

## D. DISCUSSION

Skill areas used by the OOD on watch have been identified by use of the PAQ. It is these abilities which determine the performance of the OOD. If these skills are

adversely affected by the environment, the result could be an overall decrease in the officer's ability to make correct decisions based on the soundness of his judgement. The next step is to determine how performance in these areas can be assessed under varying conditions.

# IV. AUTOMATED PORTABLE TEST SYSTEM

## A. BACKGROUND

The Automated Portable Test System (APTS), and its predecessor, Performance Evaluation Tests for Environmental Research (PETER), were designed to replace pencil and paper testing in environments where the more cumbersome traditional tests were impractical or inconvenient (Merkle and others, 1985). APTS uses a variety of software programs on small portable computers to test a number of skill areas.

Developed by the Naval Aerospace Medical Research Laboratory Detachment, New Orleans, Louisiana, and by Essex Corporation, Orlando, Florida, these tests are most effective when used to judge the effects of different environmental conditions on individuals (Kennedy and others, 1985). At present, their use in population comparison under standard conditions is limited due to the lack of population data available. However, a high correlation between APTS scores and those of their paper and pencil counterparts has been shown to exist (National Science Foundation, 1985). An added advantage of the APTS is that the real-time nature of the tests allows the study of some skills which do not lend themselves to the static format, such as the identification and tracking of a moving target.

The primary requirements for an APTS test are consistency for a given subject over multiple trials in a constant environment, sensitivity in distinguishing between individuals, and investigation of some meaningful aspect of human performance (Bittner and others, 1984, 1985). Ideally, a test will have a steep initial learning curve which flattens out to a relatively constant level after a small number of repetitions (Kennedy and others, 1980; Essex Corporation, 1985).

Software for a wide variety of physiological, psychological, and mental ability tests is currently available or is under development. Areas that tests are available for include: short term memory, visual acuity, mathematical ability, integration between brain hemispheres, spatial orientation, and reaction time (Essex Corporation, no date).

## B. CORRELATION OF APTS WITH PAQ

APTS test descriptions were matched with PAQ questions to choose the appropriate tests. In the majority of cases the choice was clear-cut, although not all of the most appropriate tests could be used. The APTS tests used in this study were dictated not only by the relevant skill areas, but also by the tests' availability. Not every test in use is available for use at the Naval Postgraduate School.

The skill areas assessed by the tests used in this study are recognition skills (questions 5,11,13,176), short term memory (questions 45,180), reasoning ability (question 37), as well as encoding ability and dynamic visual acuity. Tests for such skills as vigilance, decision making, and ability to communicate were not available. A summary of PAQ questions, skill areas, and matching APTS tests is presented in Table 2 .

## C. DESCRIPTION OF TESTS

The following is a brief description of the five APTS tests used for this experiment, as described by Essex Corporation documentation (no date). All tests are administered on a timed basis, with new problems presented as soon as the previous one has been responded to, correctly or not. Each test has a duration of one minute, and each repetition is preceded by a brief practice session.

(1) PATRNC (pattern comparison) requires the observer to compare two concurrently presented abstract patterns, and to determine if they are the same or different.

TABLE 2

MATCHED PAQ QUESTIONS AND APTS TESTS

| PAQ Question | Skill Area | APTS Test |
|---|---|---|
| 5 | Use of visual displays | PATRNC<br>STERNB |
| 11,13 | Observational abilities | PATRNC<br>STERNB<br>LANDC |
| 15 | Use of verbal information | ----- |
| 29 | Ability to estimate speed | ----- |
| 36 | Decision making skills | ----- |
| 37 | Reasoning ability | REASON |
| 39, 40 | Information processing | ----- |
| 45 | Short term memory | CODSUB<br>STERNB |
| 104,105 | Information exchange | ----- |
| 175 | Attention to detail | ----- |
| 176 | Recognition skills | PATRNC |
| 177,178 | Vigilance | ----- |
| 180 | Ability to update memory | STERNB |

Response is made by pressing an "S" or a "D" on the keyboard, as appropriate. Performance on this test is a measure of visual search and target acquisition abilities.

(2) CODSUB (code substitution) displays the numerals 1-9 beneath randomly selected letters of the alphabet. The observer refers to this "code" to assign the correct number to each of a series of letters appearing on the display below the code. This test measures encoding ability and short term memory, and is also considered a test of general intelligence.

(3) REASON (grammatical reasoning) presents a simple sentence describing the order of the letters A and B which appear after the sentence. The observer must

decide whether the statement is true or false, and enter "T" or "F" accordingly. (example: "A is not followed by B (BA)" is true). This test measures reasoning ability.

(4) STERNB (Sternberg's short term memory scanning test) displays a set of four different digits for one second. Subsequently, a series of single digits is presented, and for each the observer must decide if it was in the set ("T"), or not ("F"). This is a test of short term memory.

(5) LANDC (flying Landolt "C") displays a squared "C" shape moving from left to right across the display at varying speeds. The opening on the "C" may point up, down, left, or right. The observer indicates the correct direction by depressing one of four directional arrows on the keyboard. This test is still experimental, but is believed to assess dynamic visual acuity. Scores are calculated in centimeters per second, representing the average speed at which the observer first correctly identifies the "C".

## V. EXPERIMENTAL METHOD

### A. PURPOSE AND HYPOTHESIS

As discussed in Chapter II, there has been little research on the effects of motion on human performance, aside from motion sickness studies. This experiment investigates some effects of such motion, with the intent of determining if there is an effect on the mental performance of the OOD.

Although it is possible that the effects of motion are negative, it is also possible that the effects could be positive, as motion could cause mild stimulation to a higher performance capability, as per the Yerkes-Dodson Law (Hockey, 1979, p. 143). Thus, the null hypothesis is that there is no difference in performance on the tests between moving and non-moving subjects, against the alternate hypothesis that there is a difference, in either direction.

The effect on performance due to learning is also examined, as is correlation of test performance under conditions of both motion and non-motion with such factors as intelligence (SAT scores), sea duty experience, and time since commissioning.

### B. THE EXPERIMENT

#### 1. Participants

The experimental participants were 15 male U.S. Navy surface warfare qualified Lieutenants and Lieutenant Commanders. They volunteered, and were not paid for their services.

#### 2. Experimental Apparatus

##### a. Motion Simulator

The ship motion simulator used for this study was constructed by students and staff at the Naval

Postgraduate School, and is pictured in Figure 5.1 . The apparatus consists of a platform, which is fitted with a chair and the microcomputer. The platform is rocked angularly from side to side by an axle attached to a rotary wheel, which is driven by a 3/4 HP General Electric motor.

For this experiment, the platform was set to rotate laterally 12 degrees to either side of the horizontal, for a total arc of 24 degrees. The oscillation frequency was set at 0.06 Hz., or about 3 1/2 cycles per minute. The gentle movement was not enough to make any of the subjects motion sick, and was considered an adequate simulation for this study.

Participants were seated on the apparatus for all portions of the test, both moving and non-moving. Because it was not possible to isolate the equipment in a sound-proof environment, observers wore sound mufflers (mouse ears) throughout the testing to minimize the effects of ambient noise.

b. Testing Apparatus

The microcomputer used for this experiment is an NEC PC-8201A with a demonstration APTS package furnished by Essex Corporation. It is not equipped with memory capability, and all scores must be recorded manually.

The microcomputer provides instructions and examples for each test. These instructions are supplemented by the experimenter, who answers any questions the participants may have prior to beginning the test. Following the test, the scores are recorded, and the participant instructed to continue to the next scheduled test.

Figure 5.1 Ship Motion Simulator.

3. Experimental Design

The 15 observers were divided randomly into three groups: one control group and two experimental groups. All three groups repeated each of the five tests a total of six times, in three batteries of two sets each. The experimental design is summarized in Table 3 .

TABLE 3

EXPERIMENTAL DESIGN

| Group | Participant Numbers | Trial Battery 1 | 2 | 3 |
|---|---|---|---|---|
| Control | 1, 3, 9, 13, 14 | . | . | . |
| Ex B | 2, 4, 7, 10, 12 | . | M | . |
| Ex C | 5, 6, 8, 11, 15 | . | . | M |

note: "M" denotes trial in which ship motion is simulated, "." denotes non-moving trial.

All three groups completed the first battery while not moving. The primary purpose of this was to allow practice on the tests. The control group repeated the following two batteries in the same manner. The first experimental group (Ex B) performed the second battery while moving, and the third while stationary. The second experimental group (Ex C) reversed the order, and performed the second battery while stationary, and the third while moving.

C. DATA ANALYSIS PROCEDURES

For four of the tests, Pattern Comparison, Sternberg, Reasoning, and Code Substitution, scores are treated separately as two dependent variables; error rate, and total response rate. The error rate is the proportion of the time that an erroneous response is entered (or the percentage of the time, for graphical purposes). The total response rate represents the total number of times a response is entered, correct or not. For the Landolt "C" test, the single

measurement variable is average speed at which the target is correctly identified, recorded in centimeters per second. Each participant's results for each battery of two one-minute tests are summed for each test type. The Landolt speeds are averaged. This raw data is presented in Appendix B.

A two-way repeated measures analysis of variance is used to compare the results of the second and third batteries for the two experimental groups. The purpose of this analysis is to explore the effects of motion versus non-motion, as well as any difference between the two groups due to the order in which motion and non-motion are experienced, taking into account the differences between individuals. The hypotheses for these tests are:

Ho: There is no difference in performance between the two groups based on either variable being studied (motion or order)

H1: There is a difference in performance between the two populations based on one of these variables.

The format for the ANOVA is presented in Table 4 .

TABLE 4

ANOVA- MOTION AND ORDER EFFECTS

| Source of Variation | Degrees Freedom |
|---|---|
| Between Subjects | np-1=9 |
| Order | p-1=1 |
| Residual | p(n-1)=8 |
| Within Subjects | np(q-1)=10 |
| Motion | q-1=1 |
| Interaction | (p-1)(q-1)=1 |
| Residual | p(n-1)(q-1)=8 |
| Total | N-1=19 |

The F ratio is compared with the F distribution with degrees of freedom equal to 1 and 8. The ANOVA is performed on both error and total response rates.

The analysis of variance for the average speeds of the Landolt "C" test is slightly modified due to unequal numbers of observations. One participant in experimental group "B" failed to perform this test adequately enough to register any score, and so was dropped from the results for this test. The ANOVA method used is the unweighted means method, from Winer (1962, p. 377). The single measurement variable for performance on this test is the average speed at which the "C" is first correctly identified.

In order to determine if learning from previous practice has a significant effect on performance between the second and third trials, a one way within-subjects ANOVA is conducted for both error rate and total responses for each of the tests but Landolt, for which average speed is again the criterion used. The results from all 15 participants are used for this ANOVA. The procedure is presented in Table 5 .

TABLE 5

ANOVA- LEARNING EFFECTS

| Source of Variation | Degrees Freedom |
|---|---|
| Between Subjects | n-1=14 |
| Within Subjects | n(k-1)=15 |
| Trial number | k-1=1 |
| Residual | (n-1)(k-1)=14 |
| Total | N-1=29 |

Following these analyses, Pearson product moment correlations between each of nine variables are determined. Relationships are investigated between performance on each of the five APTS tests (measured as total number correct scored over the three batteries), and with four other variables of background information: months of sea duty experience, time since commissioning, and scores on the verbal and math portions of the Scholastic Aptitude Test (SAT), a test of general intelligence taken when the participants were in high school. The correlation analysis is performed on 12 subjects for whom complete data were available.

# VI. RESULTS

## A. PATTERN COMPARISON TEST

Figure 6.1 displays a graphical representation of percent errors and average total responses for this test. The graphs plot trial number versus performance for each of the three groups. The figure indicates a higher error rate for experimental group B during trial 2, in which that group experienced simulated ship motion. Experimental group C and the control group display a decrease in error on the second trial, and an increase on the third. Hence, both experimental groups B and C experience higher error rates while in motion. The findings of Figure 6.1 are substantiated by those of Table 6, which finds the motion effect significant at the 0.10 level, also indicating higher motion error rates. Table 6 also indicates that the interaction between the two effects for total responses is significant at the 0.01 level.

A significant learning effect for total responses is shown in Table 7 . The average total response plot of Figure 6.1 also indicates improved overall performance over these trials. It appears that one practice battery, consisting of two one-minute tests, was not sufficient to eliminate the learning effect for this test.

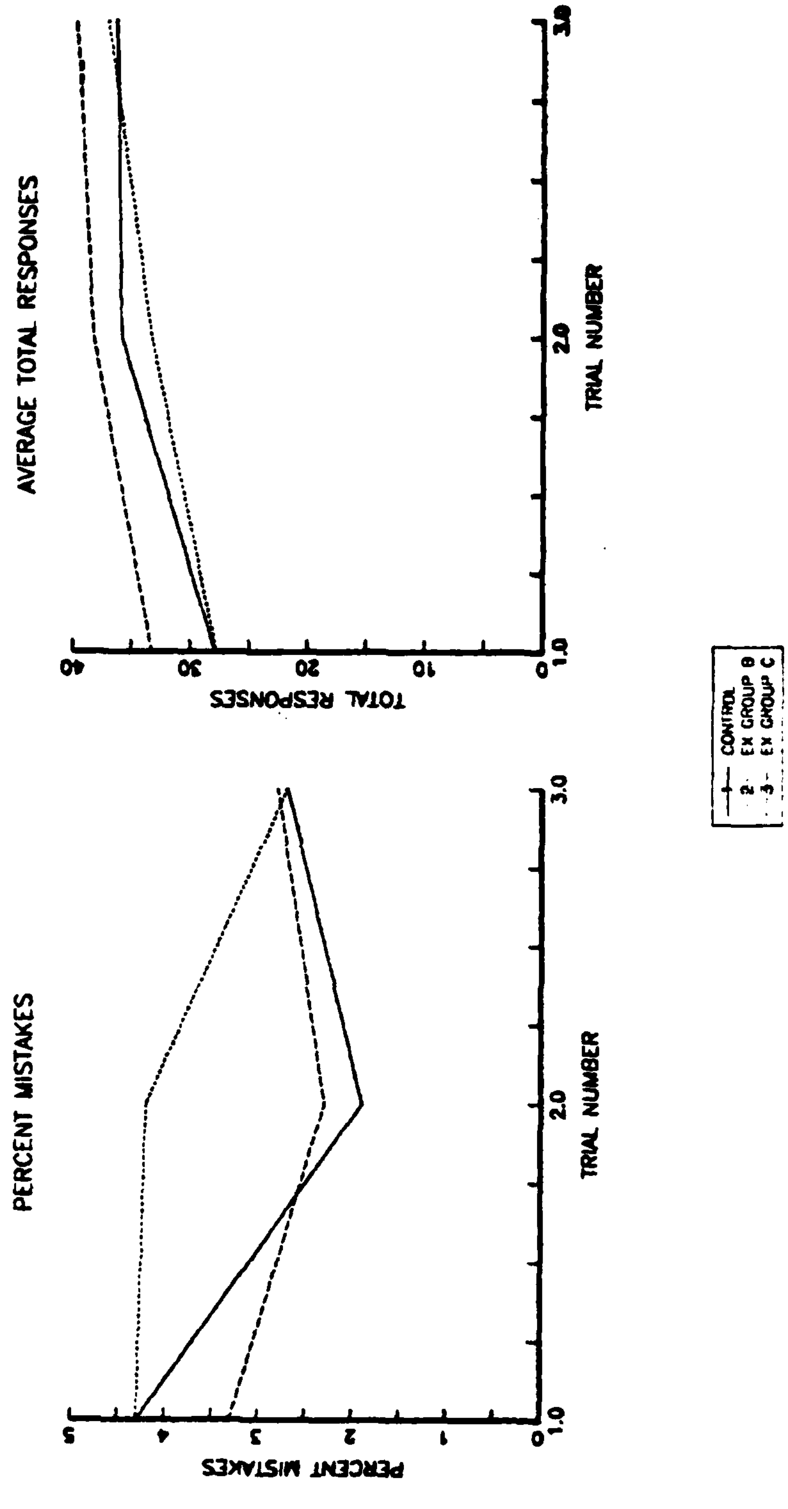


Figure 6.1 Pattern Comparison Test Results.

TABLE 6

PATTERN COMPARISON MOTION AND ORDER EFFECTS
(EX B AND EX C)

PERCENT ERRORS

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 5.75E-3 | | |
| Order effect | 1 | 3.90E-4 | 3.90E-4 | 0.58 |
| Residual | 8 | 5.36E-3 | 6.70E-4 | |
| Within Subjects | 10 | 3.75E-3 | | |
| Motion effect | 1 | 4.70E-4 | 4.70E-4 | 1.20 |
| Interaction | 1 | 1.40E-4 | 1.40E-4 | 0.36 |
| Residual | 8 | 3.14E-3 | 3.93E-4 | |
| Total | 19 | | | |

TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 3118.45 | | |
| Group Effect | 1 | 296.45 | 296.45 | 0.84 |
| Residual | 8 | 2822.00 | 352.75 | |
| Within Subjects | 10 | 216.5 | | |
| Motion effect | 1 | 26.45 | 26.45 | 4.27 |
| Interaction | 1 | 140.45 | 140.45 | 22.66 |
| Residual | 8 | 49.6 | 6.2 | |
| Total | 19 | | | |

TABLE 7

PATTERN COMPARISON LEARNING EFFECT
(ALL GROUPS)

PERCENT ERRORS

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 1.22E-2 | | |
| Within Groups | 15 | 4.63E-3 | | |
| Learning effect | 1 | 1.00E-5 | 1.00E-5 | 0.03 |
| Residual | 14 | 4.62E-3 | 3.30E-4 | |
| Total | 29 | | | |

TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 6015.87 | | |
| Within Groups | 15 | 250.00 | | |
| Learning effect | 1 | 112.14 | 112.14 | 11.39 |
| Residual | 14 | 137.86 | 9.85 | |
| Total | 29 | | | |

## B. CODE SUBSTITUTION TEST

Although Figure 6.2 indicates that experimental groups "B" and "C" again display higher error rates for the motion-related trial, the ANOVA in Table 8 indicates significance only at the 0.25 level. The total response section of this table also attributes a 0.10 significance to the interaction of group affiliation and motion. Table 9 finds the learning effect for this measure significant at the 0.10 level.

The average total response graph of Figure 6.2 reflects overall group differences between the three groups, and Table 8 indicates a significant order effect difference of 0.10 between experimental groups B and C.

## C. REASONING TEST

For this test, Figure 6.3 again shows experimental groups B and C having unusual error rates for the trial associated with motion. In this case, however, the error rate tends to be smaller when motion is occurring. Table 10 finds these results significant at the 0.10 level. A 0.10 significant interaction effect is again noted between the group and motion variables for total responses. There is also a 0.10 significant learning effect for this measure indicated by Table 11 .

## D. STERNBERG TEST

Figure 6.4 indicates that again both experimental groups B and C exhibit decreased error rates for the trial associated with motion. However, Table 12 attributes no significance to this observation. Figure 6.4 also indicates an overall upward trend with trial number in average total responses for all three groups. The ANOVA of Table 13 finds this significant at the 0.10 level, indicating that a learning effect is quite probable between the second and third trials for the three groups. No interaction effects are noted in Table 12 .

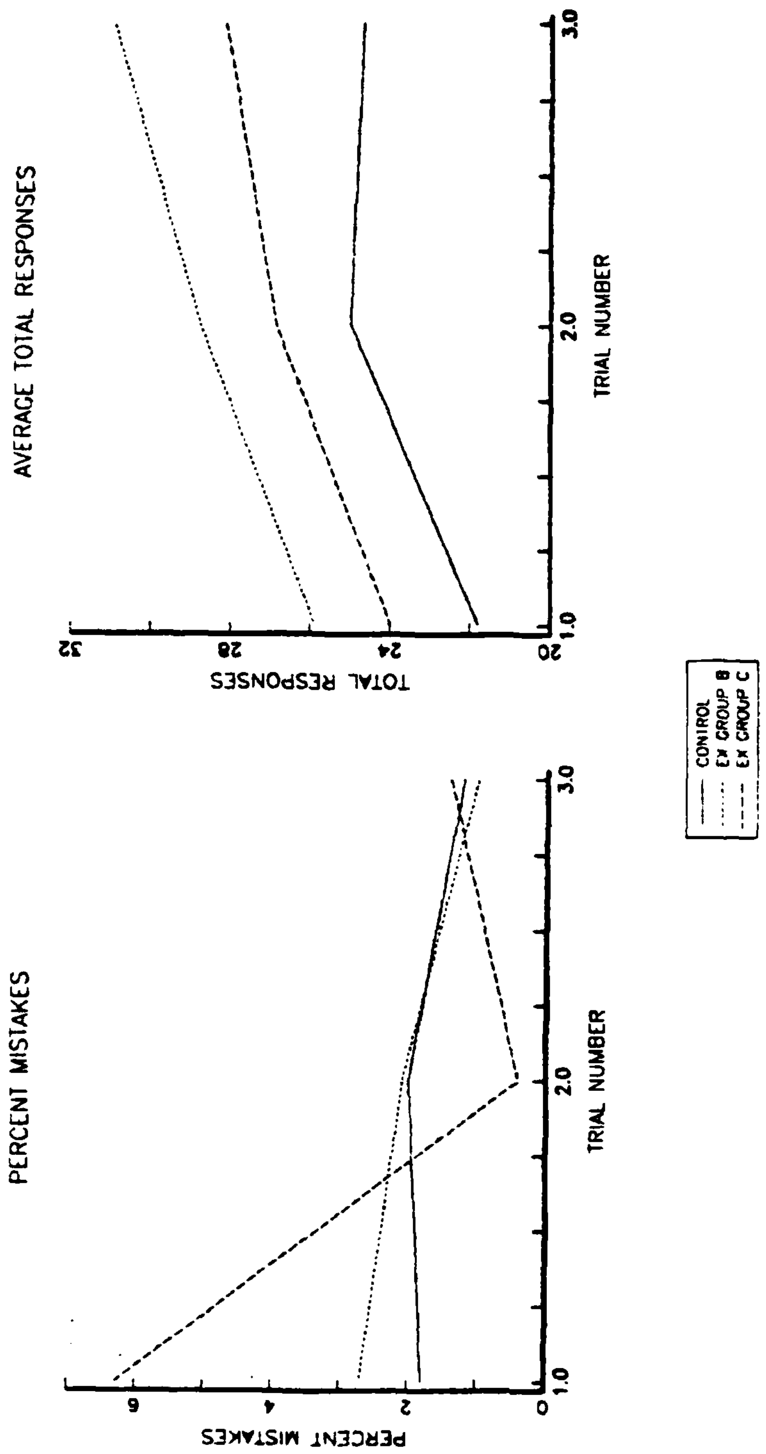


Figure 6.2 Code Substitution Test Results.

## TABLE 8

## CODE SUBSTITUTION MOTION AND ORDER EFFECTS (EX B AND EX C)

### PERCENT ERRORS

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 3.88E-3 | | |
| Order effect | 1 | 2.31E-4 | 2.31E-4 | 0.51 |
| Residual | 8 | 3.65E-3 | 4.56E-4 | |
| Within Subjects | 10 | 2.36E-3 | | |
| Motion effect | 1 | 6.50E-4 | 6.50E-4 | 3.05 |
| Interaction | 1 | 7.40E-6 | 7.40E-6 | 0.04 |
| Residual | 8 | 1.70E-3 | 2.13E-4 | |
| Total | 19 | | | |

### TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 2404.45 | | |
| Group effect | 1 | 110.45 | 110.45 | 0.39 |
| Residual | 8 | 2294.00 | 286.75 | |
| Within Subjects | 10 | 158.50 | | |
| Motion effect | 1 | 4.05 | 4.05 | 0.35 |
| Interaction | 1 | 61.25 | 61.25 | 5.26 |
| Residual | 8 | 93.2 | 11.65 | |
| Total | 19 | | | |

## TABLE 9

## CODE SUBSTITUTION LEARNING EFFECT (ALL GROUPS)

### PERCENT ERRORS

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 7.20E-3 | | |
| Within Groups | 15 | 2.85E-3 | | |
| Learning effect | 1 | 8.70E-5 | 8.70E-5 | 0.44 |
| Residual | 14 | 2.76E-3 | 1.97E-4 | |
| Total | 29 | | | |

### TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 3650.47 | | |
| Within Groups | 15 | 189.00 | | |
| Learning effect | 1 | 34.14 | 34.14 | 3.09 |
| Residual | 14 | 154.86 | 11.06 | |
| Total | 29 | | | |

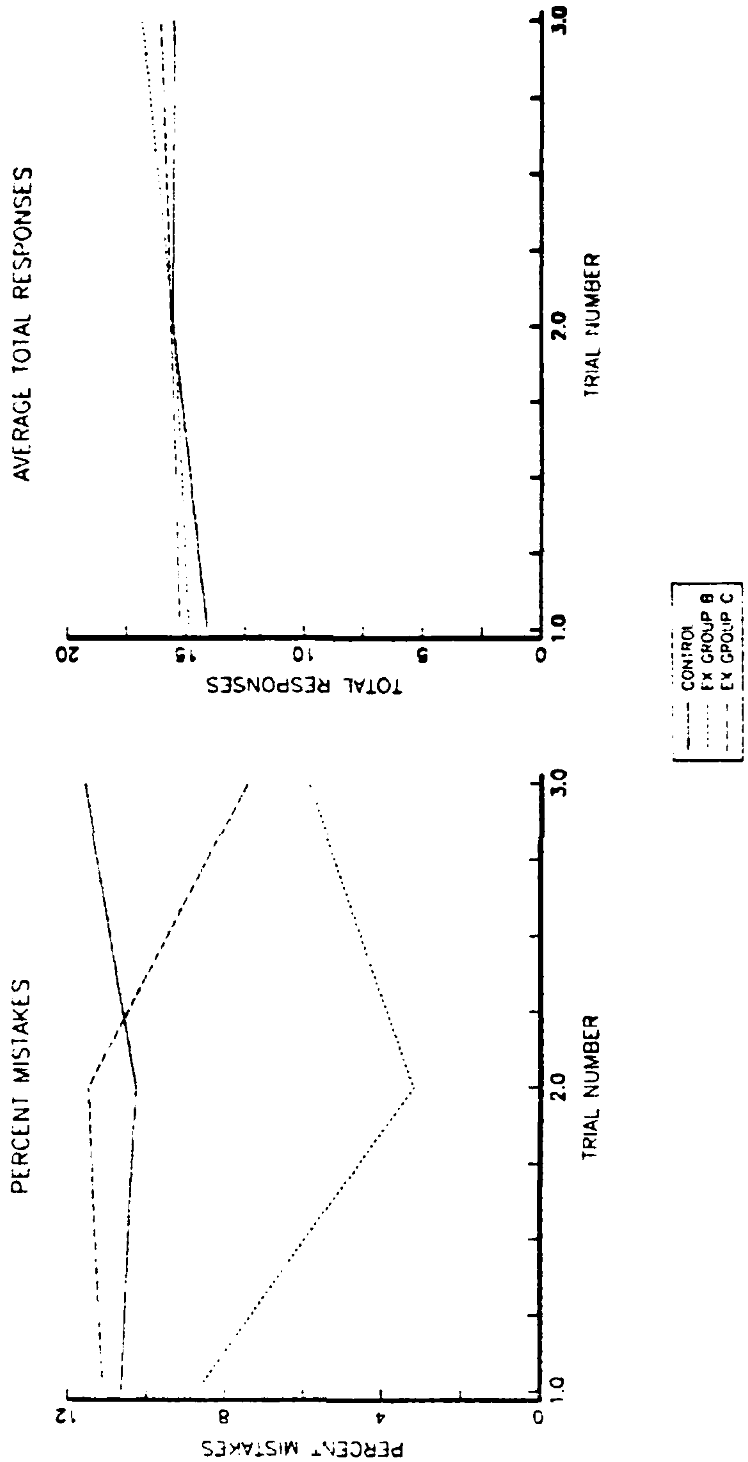


Figure 6.3 Reasoning Test Results.

## TABLE 10

## REASONING MOTION AND ORDER EFFECTS
## (EX B AND EX C)

### ERROR RATES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 2.56E-2 | | |
| Order effect | 1 | 9.50E-3 | 9.50E-3 | 4.72 |
| Residual | 8 | 1.61E-2 | 2.01E-3 | |
| Within Subjects | 10 | 1.49E-2 | | |
| Motion effect | 1 | 4.32E-3 | 4.32E-3 | 3.51 |
| Interaction | 1 | 7.50E-4 | 7.50E-4 | 0.61 |
| Residual | 8 | 9.84E-3 | 1.23E-3 | |
| Total | 19 | | | |

### TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 1135.25 | | |
| Group effect | 1 | 2.45 | 2.45 | 0.02 |
| Residual | 8 | 1132.80 | 141.60 | |
| Within Subjects | 10 | 52.50 | | |
| Motion effect | 1 | 4.05 | 4.05 | 1.07 |
| Interaction | 1 | 18.05 | 18.05 | 4.75 |
| Residual | 8 | 30.40 | 3.80 | |
| Total | 19 | | | |

## TABLE 11

## REASONING LEARNING EFFECT
## (ALL GROUPS)

### PERCENT ERRORS

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 4.19E-2 | | |
| Within Groups | 15 | 4.59E-2 | | |
| Learning effect | 1 | 1.00E-4 | 1.00E-4 | 0.03 |
| Residual | 14 | 4.58E-2 | 3.27E-3 | |
| Total | 29 | | | |

### TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 1446.20 | | |
| Within Groups | 15 | 64.50 | | |
| Learning effect | 1 | 12.03 | 12.03 | 3.21 |
| Residual | 14 | 52.47 | 3.75 | |
| Total | 29 | | | |

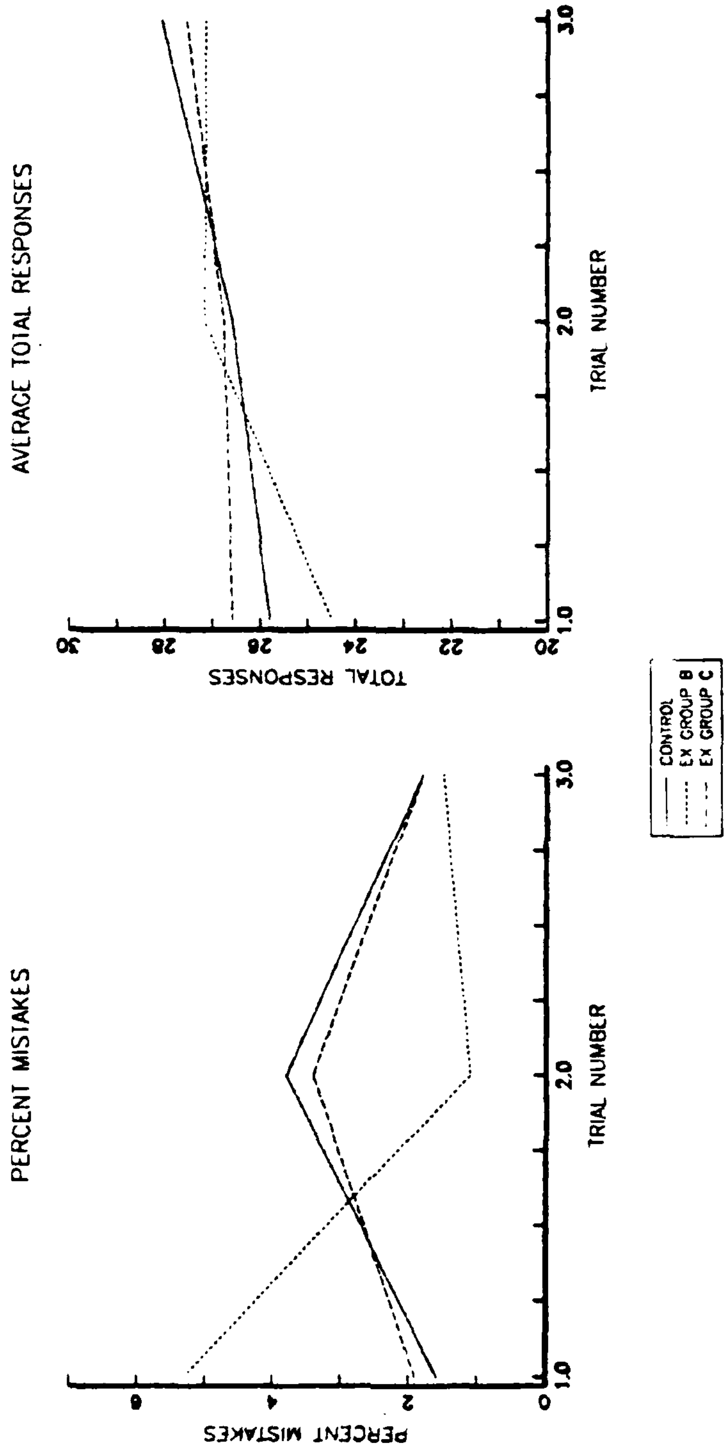


Figure 6.4 Sternberg Test Results.

## TABLE 12

## STERNBERG MOTION AND ORDER EFFECTS
## (EX B AND EX C)

### ERROR RATES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 6.53E-3 | | |
| Order effect | 1 | 1.04E-3 | 1.04E-3 | 1.51 |
| Residual | 8 | 5.49E-3 | 6.86E-4 | |
| Within Subjects | 10 | 3.32E-3 | | |
| Motion effect | 1 | 2.74E-4 | 2.74E-4 | 0.73 |
| Interaction | 1 | 3.60E-5 | 3.60E-5 | 0.10 |
| Residual | 8 | 3.01E-3 | 3.76E-4 | |
| Total | 19 | | | |

### TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 9 | 1453.80 | | |
| Group effect | 1 | 0.00 | 0.00 | 0.00 |
| Residual | 8 | 1453.80 | 181.72 | |
| Within Subjects | 10 | 45.00 | | |
| Motion effect | 1 | 3.20 | 3.20 | 0.66 |
| Interaction | 1 | 3.20 | 3.20 | 0.66 |
| Residual | 8 | 38.60 | 4.83 | |
| Total | 19 | | | |

## TABLE 13

## STERNBERG LEARNING EFFECT
## (ALL GROUPS)

### PERCENT ERRORS

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 1.12E-2 | | |
| Within Groups | 15 | 6.10E-3 | | |
| Learning effect | 1 | 6.00E-4 | 6.00E-4 | 1.53 |
| Residual | 14 | 5.50E-3 | 3.93E-4 | |
| Total | 29 | | | |

### TOTAL RESPONSES

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 14 | 2227.00 | | |
| Within Groups | 15 | 86.50 | | |
| Learning effect | 1 | 17.63 | 17.63 | 3.59 |
| Residual | 14 | 68.87 | 4.92 | |
| Total | 29 | | | |

## E. LANDOLT TEST

The average speed measure for this test indicates a sharp increase in performance from the first to the second trial, as indicated in Figure 6.5 . This overall increase is not carried past the second trial, however, and little difference is noted between the second and third trials. Table 15 bears out this finding by indicating no significant learning effect between these trials.

Table 14 finds no significant differences in either measure of performance between the two experimental groups due to motion or order effects. This agrees with data representation in Figure 6.5 .

## F. CORRELATION ANALYSIS

The Pearson product moment correlations among performance on the five tests and the four items of background data are summarized in Table 16 . The background data items are: verbal (VER) and math (MAT) SAT scores, sea duty experience (SDE), and time since commissioning (TSC).

The correlations among the five APTS tests are, in general, significantly positive (greater than 0.5). The only exceptions to this are the Code Substitution and Sternberg tests, which have smaller but still positive correlations with the Landolt test. The only other significantly high correlation of any importance is between performance on the Pattern Recognition test and math SAT scores.

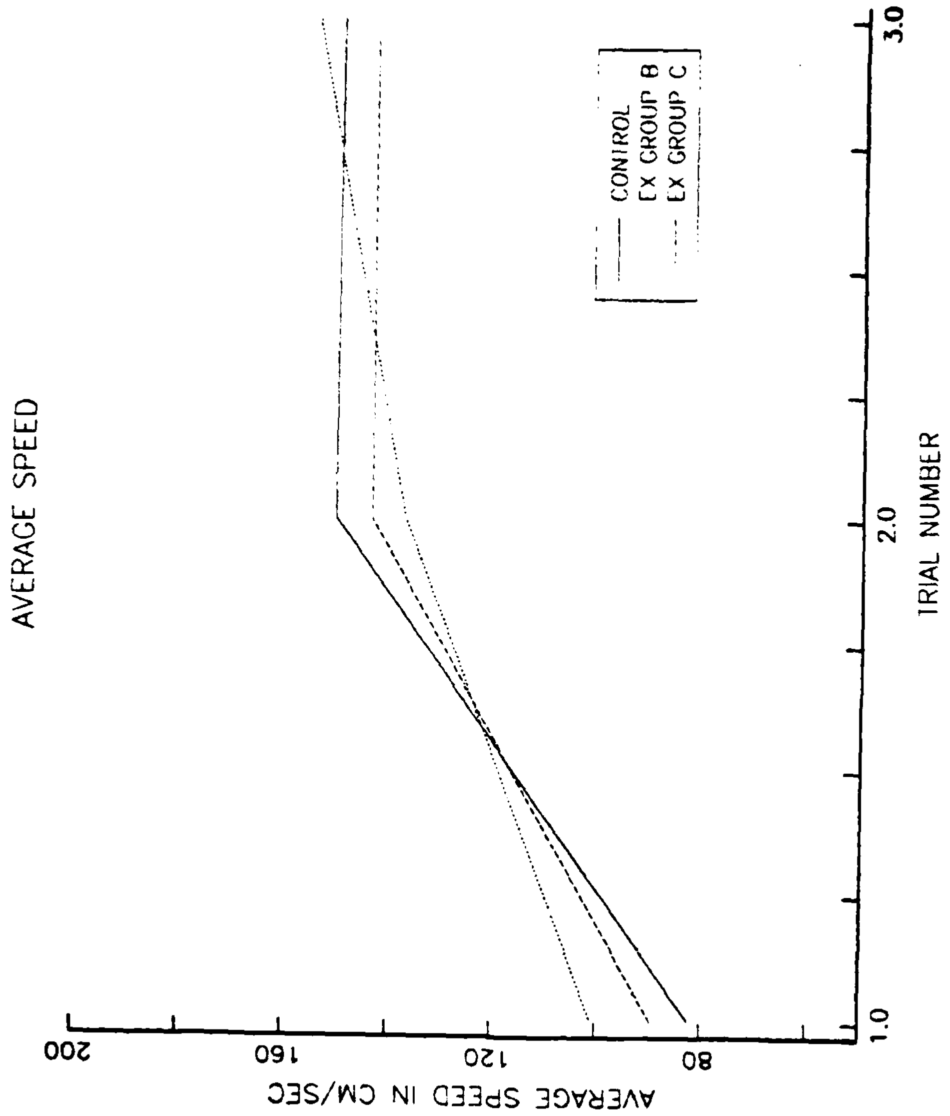


Figure 6.5 Landolt Test Results.

TABLE 14

LANDOLT C MOTION AND ORDER EFFECTS
(EX B AND EX C)

AVERAGE SPEED

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Subjects | 8 | | | |
| Order effect | 1 | 25.47 | 25.47 | 0.002 |
| Residual | 1 | 72741.95 | 10391.71 | |
| Within Subjects | 9 | | | |
| Motion effect | 1 | 349.24 | 349.24 | 0.18 |
| Interaction | 1 | 349.33 | 349.33 | 0.18 |
| Residual | 8 | 13790.64 | 1970.09 | |
| Total | 17 | | | |

TABLE 15

LANDOLT C LEARNING EFFECT
(ALL GROUPS)

AVERAGE SPEED

| Source of Variation | DF | SS | MS | F |
|---|---|---|---|---|
| Between Groups | 13 | 119240.47 | | |
| Within Groups | 14 | 16513.25 | | |
| Learning effect | 1 | 171.76 | 171.76 | 0.14 |
| Residual | 13 | 16341.49 | 1257.04 | |
| Total | 27 | | | |

TABLE 16

CORRELATION BETWEEN APTS TESTS AND BACKGROUND DATA

| | PAT | REA | COD | STE | LAN | VER | MAT | SDE | TSC |
|---|---|---|---|---|---|---|---|---|---|
| PATRNC | 1.00 | .52 | .67 | .74 | .59 | .05 | .51 | -.25 | -.20 |
| REASON | | 1.00 | .64 | .70 | .60 | .31 | -.30 | -.02 | .00 |
| CODSUB | | | 1.00 | .68 | .36 | -.18 | -.06 | -.26 | -.10 |
| STERNB | | | | 1.00 | .25 | .02 | .23 | -.24 | -.10 |
| LANDC | | | | | 1.00 | .27 | .06 | .14 | .00 |
| V. SAT | | | | | | 1.00 | .03 | .14 | .00 |
| M. SAT | | | | | | | 1.00 | -.12 | .00 |
| SDE | | | | | | | | 1.00 | .80 |
| TSC | | | | | | | | | 1.00 |

## VII. CONCLUSIONS

The five objectives outlined in Chapter I have been addressed by this project. The following is a summary and discussion of these findings.

Results from the PAQ identified a number of cognitive skills crucial to the OOD's performance. These are: visual recognition and observational abilities; information analysis, processing, and storage capabilities; reasoning and ability to make decisions; short term memory; ability to communicate effectively; speed estimation; and vigilance and attention to detail.

Not all of these skills lend themselves to standardized testing, and not all that are so suited actually have a test available for them. Such critical characteristics as vigilance and ability to make decisions could not be addressed by this study. The following skills were studied: visual skills, reasoning, short term memory, recognition, and ability to update memory.

Those tests administered to examine motion effects on these skills yielded mixed results. A 0.10 significant negative effect due to motion was found for the Pattern Comparison and Reasoning tests' total response rate. Motion caused a slight increase in the Code Substitution error rate. In addition, graphical plots of error rate versus trial number give some indication that error rate is related to motion. Motion appears to increase error rate for the Pattern Comparison and Code Substitution tests, but to decrease error rates on the Reasoning and Sternberg tests.

This varying effect on error rates may be explained by the Yerkes-Dodson law (Hockey, 1979, p. 143). The arousal level caused by the ship motion simulator may be close to optimal for some tests, but too high for others, causing a

negative impact. The Pattern Comparison and Code Substitution tests both require relatively rapid and automatic responses, while the Reasoning test requires longer consideration, and the Sternberg test requires concentration to retain facts in memory. It is possible that the Reasoning and Sternberg tests, which rely more heavily on the ability to concentrate, are benefited by mild arousal. Perfomance on the Pattern Recognition and Code Substitution tests, which rely on rapid, almost reflexive action, may suffer from the stimulation.

The purpose of correlating performance on these tests with background data is to pave the way for prediction models to be used in the selection and qualification of Surface Warfare officers. However, the only significant correlation noted was between Pattern Recognition ability and score on the math SAT. No other significant correlations were found.

The APTS proved to be ideally suited to this type of study. The tests are easily administered, and little physical activity is required which could be affected by motion. Unfortunately, the two practice tests of one minute each did not generally prove to be sufficient to stabilize individual performance levels. For the Pattern Comparison, Reasoning, Code Substitution, and Sternberg tests, significant learning effects were noted between the second battery (third and fourth tests), and the third battery (fifth and sixth tests). In future studies, more practice sessions would be advisable for these tests.

The Landolt test proved to be the one weak point of the APTS. The test format was unsettling to observers, who often believed that the display was malfunctioning. In addition to this, the performance of a single participant varied so widely from one session to another that any underlying motion, group, or learning effects were effectively lost in the noise.

The very skills that an OOD may need to call upon under stressful conditions may themselves be affected by those conditions. An important criterion for the qualification of those officers who will be placed in positions of responsibility should be that their performance under conditions such as extreme ship motion is adequate to the task. Increased error rate may have more far reaching consequences than depressed response rate, and safeguards to prevent simple errors from becoming major disasters are crucial.

## APPENDIX A

## SELECTED QUESTIONS FROM THE POSITION ANALYSIS QUESTIONNAIRE

The following PAQ questions used for this study are reprinted from Harris and McCormick (no date).

I) Rate each of the following items in terms of how much it is used by the worker as a source of information in performing his billet.

5) Visual displays (dials, gauges, signal lights, radar scopes, speedometers, clocks, graphic displays, etc.)

11) Man-made features of environment (structures, ships, buildings, dams, highways, bridges, docks, and other "man-made" or altered aspects of the indoor or outdoor environment which are observed or inspected to provide job information.)

13) Events or circumstances (those events the worker visually observes and in which he may participate, such as movements of ships, movement of materials, airport control tower operations, etc.)

15) Verbal sources (verbal instructions, orders, requests, conversations, interviews, discussions, formal meetings, etc.; consider only verbal communication which is relevant to job performance.)

II) In this section are various operations involving estimation or judging activities. In each case consider activities in which the worker may use any or all of the senses; for example, sight, hearing, touch, etc. Continue using the "Importance to Billet" scale.

29) Estimating speed of moving objects (estimating the speed of moving objects or materials relative to a fixed point or to other moving objects; for example, the speed of vessels or aircraft, materials on a conveyor belt, etc.)

III) Decision making, Reasoning, and Planning/Scheduling

36) Decision making (indicate, using the code below, the level of decision making typically involved in the billet, considering: the number and complexity of the factors that are taken into account; the variety of alternatives available; the consequences and importance of the decisions; the background experience, education, and training required; the precedents available for guidance; and other relevant considerations. The examples given for the following codes are only suggestive.)

(1) Low ("decisions" such as those in selecting parts in routine cleaning, shelving items in a storeroom, etc.)
(2) Below Average ("decisions" such as those in operating or dispatching vehicles, lubricating a truck, etc.)
(3) Average ("decisions" such as those in setting-up machine tools for operation, diagnosing mechanical disorders of aircraft, ordering office supplies several months in advance, etc.)
(4) Above Average ("decisions" such as those in making personnel decisions such as promotions and disciplinary actions, determining flight plan, etc.)
(5) High ("decisions" such as those in recommending major surgery, determining battle strategy, etc.)

37) Reasoning in problem solving (indicate, using the code below, the level of reasoning that is required of the worker in applying his knowledge, experience, and judgement to problems.)

(1) Low (use of common sense to carry out simple, or relatively uninvolved instructions; for example, sweeper, messenger, stores working party, etc.)

(2) Below Average (use of some training and/or experience to select from a limited number of solutions the most appropriate action or procedure in performing the billet; for example issuing clerk, mess stewards, etc.)

(3) Average (use of relevant principles to solve practical problems and to deal with a variety of concrete variables in situations where only limited standardization exists; for example, draftsman, carpenter, ship navigation, non-routine repair of mechanical equipment, etc.)

(4) Above Average (use of logic or scientific thinking to define problems, collect information, establish facts, and draw valid conclusions; for example, individual with major responsibilities for diagnosis and repair of complex electronic and weapon systems, aeronautical engineering officer, etc.)

(5) High (use of principles of logical or scientific thinking to solve a wide range of intellectual and practical problems; for example, commanding a vessel, research scientists, etc.)

IV) In this section are various human operations involving the "processing" of information or data. Rate each of the following items in terms of how important the activity is to the completion of the job.

39) Combining information ( combining, synthesizing, or integrating information or data from two or more sources to establish new facts, hypotheses, theories, or a more complete body of related information; for example, integrating intelligence information, a pilot flying an aircraft, a weatherman using information from various sources to predict weather conditions, radarman, signalman, etc.)

40) Analyzing information or data (for the purpose of identifying underlying principles or facts by breaking down information into component parts; for example, interpreting intelligence reports, diagnosing mechanical disorders or medical symptoms, ECM operators, etc.)

45) Short-term memory (learning and retaining job-related information and recalling that information after a brief period of time; for example, cook, telephone operator, helmsman, messenger, etc.)

V) This section deals with different aspects of interaction between people involved in various kinds of work.

104) Routine information exchange (the giving and/or receiving of information of a routine or simple nature; for example, radio operator, receptionist, information clerk, etc.)

105) Non-routine information exchange (the giving and/or receiving of information of a non-routine or complex nature; for example, engineers discussing shipyard overhaul, officers' call, CIC to OOD, lookout to OOD, etc.)

VI) This section lists various types of demands that the job situation may impose upon the worker, usually requiring that he adapt to these in order to perform his work satisfactorily. Rate the following items in terms of how important they are to the billet.

175) Attention to detail (need to give careful attention to various details of one's work, being sure that nothing is left undone.)

176) Recognition (need to identify, recognize, or "perceive" certain objects, events, processes, behavior, etc., or aspects, features, or properties thereof; this item is primarily concerned with "recognition" of that which is "sensed" by vision, hearing, touch, etc.)

177) Vigilance: infrequent events (need to continually search for <u>very infrequently</u> occurring but relevant events in the job situation; for example, look-out watch, observing instrument panel to identify infrequent change from "normal", etc.)

178) Vigilance: continually changing events (need to be continually aware of variations in a continually or frequently changing situation; for example, driving in traffic, controlling aircraft traffic, continually watching frequently changing dials and gauges, etc.)

180) Updating job knowledge (need to keep knowledge current, being informed of new developments related to the billet.)

# APPENDIX B

## RAW DATA SCORES

Each data point represents the sum over two one-minute trials. The format for all tests but Landolt is as follows: number correct/ number of responses. Landolt scores are recorded as speeds in centimeters per second.

| No. | Group | Trial | PATRNC | REASON | CODSUB | STERNB | LANDC |
|---|---|---|---|---|---|---|---|
| 1 | Control | 1 | 49/51 | 19/22 | 50/50 | 48/50 | 60.95 |
| | | 2 | 65/66 | 22/27 | 53/53 | 47/50 | 110.90 |
| | | 3 | 60/60 | 22/24 | 54/54 | 55/55 | 73.95 |
| 2 | Ex B | 1 | 48/50 | 16/19 | 41/41 | 42/45 | 48.95 |
| | | 2 | 51/52 | 18/20 | 41/42 | 48/50 | 46.30 |
| | | 3 | 60/63 | 23/23 | 47/47 | 45/47 | 102.05 |
| 3 | Control | 1 | 56/62 | 31/34 | 44/46 | 56/58 | 83.85 |
| | | 2 | 71/75 | 27/32 | 49/50 | 56/58 | 137.60 |
| | | 3 | 70/77 | 33/35 | 55/55 | 60/63 | 157.80 |
| 4 | Ex B | 1 | 71/72 | 31/34 | 65/66 | 59/62 | 181.40 |
| | | 2 | 86/86 | 42/42 | 69/71 | 68/68 | 110.20 |
| | | 3 | 93/94 | 41/43 | 83/83 | 69/69 | 200.30 |
| 5 | Ex C | 1 | 65/66 | 33/33 | 44/50 | 54/55 | 160.75 |
| | | 2 | 80/83 | 33/37 | 56/56 | 50/52 | 290.20 |
| | | 3 | 75/80 | 39/42 | 55/55 | 58/58 | 233.30 |
| 6 | Ex C | 1 | 60/62 | 20/23 | 37/38 | 41/42 | 87.95 |
| | | 2 | 58/60 | 23/26 | 41/42 | 44/46 | 151.25 |
| | | 3 | 63/66 | 25/27 | 42/44 | 41/43 | 195.90 |
| 7 | Ex B | 1 | 48/54 | 23/26 | 42/42 | 38/40 | ------ |
| | | 2 | 56/60 | 23/25 | 45/48 | 48/49 | ------ |
| | | 3 | 63/64 | 22/25 | 43/44 | 48/50 | ------ |

| No. | Group | Trial | PATRNC | REASON | CODSUB | STERNB | LANDC |
|---|---|---|---|---|---|---|---|
| 8 | Ex C | 1 | 64/65 | 33/35 | 49/55 | 63/65 | 79.50 |
| | | 2 | 83/84 | 37/40 | 64/64 | 63/66 | 105.45 |
| | | 3 | 86/87 | 36/38 | 65/67 | 70/70 | 96.00 |
| 9 | Control | 1 | 74/75 | 27/33 | 54/54 | 60/60 | 87.10 |
| | | 2 | 102/102 | 37/40 | 65/66 | 65/67 | 278.10 |
| | | 3 | 104/105 | 38/41 | 60/61 | 69/69 | 254.60 |
| 10 | Ex B | 1 | 57/59 | 32/34 | 61/62 | 43/48 | 123.60 |
| | | 2 | 76/82 | 34/34 | 70/70 | 53/53 | 286.90 |
| | | 3 | 84/87 | 35/38 | 70/71 | 52/52 | 183.20 |
| 11 | Ex C | 1 | 60/64 | 18/27 | 44/45 | 43/44 | 76.40 |
| | | 2 | 68/71 | 18/20 | 47/47 | 43/44 | 100.60 |
| | | 3 | 72/73 | 22/23 | 54/54 | 39/42 | 96.05 |
| 12 | Ex B | 1 | 42/43 | 34/36 | 43/48 | 50/50 | 48.80 |
| | | 2 | 51/54 | 34/35 | 57/57 | 52/52 | 104.40 |
| | | 3 | 62/64 | 39/41 | 64/65 | 54/54 | 133.05 |
| 13 | Control | 1 | 44/45 | 28/30 | 31/33 | 40/40 | 123.90 |
| | | 2 | 53/54 | 29/30 | 38/40 | 37/40 | 148.60 |
| | | 3 | 56/57 | 25/31 | 35/37 | 43/45 | 191.65 |
| 14 | Control | 1 | 44/46 | 21/22 | 35/35 | 50/50 | 55.00 |
| | | 2 | 61/62 | 25/27 | 40/41 | 51/51 | 75.50 |
| | | 3 | 64/65 | 20/25 | 40/40 | 49/49 | 71.25 |
| 15 | Ex C | 1 | 73/76 | 32/35 | 51/52 | 60/60 | 42.65 |
| | | 2 | 86/86 | 28/34 | 60/60 | 59/60 | 69.45 |
| | | 3 | 92/93 | 28/32 | 62/62 | 63/63 | 95.80 |

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